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ABSTRACT

Twenty-seven Louisiana participants in the Middle School Teachers Enhancement Project (MSTEP) were surveyed about the use of the Texas Instruments Math Explorer calculator. An assessment was made to determine the teachers' own existing knowledge of how to use the calculator and guide a program for calculator skill development. Of the 28 total function keys on the calculator, the teachers knew an average of 12 keys. Following participation in MSTEP, the teachers knew an average of 25 out of the 28 keys. The conclusion is that MSTEP provided the teachers with a substantial foundation for using calculators in the classroom, and that the techniques used to teach the teachers could be used with middle school students. Part of the project was to model instructional techniques that are to be used in a "reformed" math classroom, including appropriate calculator use beyond simple addition, subtraction, multiplication and division. Further, teachers showed changes in their ability to use calculators in the classroom and adopted a more positive attitude towards reformed mathematics. (AIM)

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Evaluation of Mathematics Reform

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Louisiana Systemic Initiatives Program (LaSIP) has funded several Mathematics and Science programs for elementary, middle school, and high school teachers. The general purpose of LaSIP is to reform math and science classes. This essentially means to have the students be active learners, investigators, explorers, and developers of their own thinking.

Within mathematics, standards for reforming the curriculum, teaching practices, and assessment have been developed. In 1989, the National Council of Teachers of Mathematics (NCTM) developed the Curriculum Standards for mathematics. These standards laid out the expectations of what a "well-prepared" students should be exposed to. Additionally, these standards provide a basis for what students should be doing in a "reformed" mathematics classroom. Later, Professional Standards and Evaluation Standards have been published. The Professional Standards relate to how a mathematics teacher needs to reform and continue to grow professionally. The Evaluation Standards discuss the need for a variety of assessments, including but not limited to teacher-made tests, observations, portfolios, group assignments, and research.

One program funded, since the beginning, was the Middle School Teachers Enhancement Project (MSTEP). MSTEP conducts a six-week workshop for middle school mathematics teachers (6th - 8th grade). These teachers learn about the NCTM Standards, as well as experience "Standards-based-teaching". Through MSTEP teachers enhance their mathematical skills, learn about the NCTM standards, experience "Standards-based-teaching", and have opportunities to develop "Standards-based-lessons" to bring to their classrooms.

One basic objective is to prepare teachers and thus their students for in the 21st century. Technology is an important aspect of life today, and becoming an even more important presence in life and school. There is a necessity to integrate technology in mathematics classes. Simple exposure is not enough.

Today's technology can be used to explore and develop ideas. Technology includes calculators, educational computer software, computational computer software, the internet, and other computer applications. Both calculators and computers are necessary equipment to prepare students for the present let alone the future. Teachers as well as students need to understand and use this technology in a variety of ways, but also in educationally appropriate ways. Thus, technology is one of the important aspects of MSTEP and many other LaSIP projects.

The following results from self-report instruments was derived from the 27 participants who completed the MSTEP project. These participants filled out these surveys in May 1996 prior to beginning the project and answered these same questionnaires again the last day of the project in July 1996.

Teachers Using Technology

In May 1996, the MSTEP participants were asked to circle all the Math Explorer Keys they knew how to use (See The Math Explorer Calculator). These same teachers were asked in July 1996 to do the same. The purpose was to determine the level of calculator knowledge. The Texas Instruments Math Explorer was used because this has tended to be the calculator of choice in elementary and middle schools. Additionally, the Math Explorer has several unique keys and features that allows lessons exploring aspects of mathematics easier.

Obviously, if someone does not how to use the features of a calculator, then it is difficult for that person to use the full power of the technology. This assessment was used to determine existing knowledge and help guide the program to the level of calculator skill development necessary. The Math Explorer was used as an instructional tool throughout MSTEP, but also addressed directly to model uses of several of the unique features of the calculator. The following discussion is a product of this self-report instrument.

The Math Explorer keys were divided into three categories: Basic calculator keys, Scientific calculator keys, and Keys Unique to the Explorer. The number, decimal, backspace, clear, and ON buttons wee not assessed. Basic calculator keys included addition, subtraction, multiplication division, equal, square root, and percent; this was a total of seven keys. The Scientific calculator keys included parentheses, plus/minus, memory plus, memory minus, memory recall x^2, 10^x, y^x, 1/x, and pi; this was a total of 11 keys. Finally, the keys Unique to the Explorer included Unit, /, F-D, Simp, A b/c, x-y, Cons, Fix, integer division, and x-m; this was a total of ten keys.

The box-and-whisker plot of the calculator keys displays the four quartiles. Observing change in the Basic keys, there was a range in the number of Basic keys known in May. The mean was 6.0370 and a range from five to seven keys known. Most of the keys participants did not know generally included percent, and/or square root. On the Basic keys post-test, the mean was 6.819 and the range was from six to seven keys known. Actually, there was two people who were still unsure of the percent key. The change from the pre-test to the post-test was statistically significant (p=.007). Table 1 presents the results of paired t-tests relating to the calculator keys.

Noteworthy change was also made on the Scientific keys. The mean on the pretest was 4.1852. As seen on the box-and-whisker plot, there was a wide range from knowing none of the keys to knowing all of the keys. The median score on the pre-test was three. Significant change was made on the post-test. The minimum score was seven with a maximum score 11 (all keys). The median was also 11 for the Scientific keys post-test. The mean change was 5.667 which was statistically significant (p=.000).

Table 1
Paired T-test Results for
Math Explorer Calculator Keys

Category	Pre-test Mean	Post-test Mean	T	p
Basic	6.0370	6.8519	2.94	0.007
Scientific	4.1852	9.8148	7.69	0.000
Unique	1.5926	8.4074	12.46	0.000

Table 2
Paired T-test Results for
What I Believe Questionnaire

Item	Pre-test Mean	Post-test Mean	T	p
1. Homogeneous Classes	3.296	3.615	1.00	0.327
2. Calculators in Classroom	3.633	3.667	0.20	0.843
3. Struggling with Problems	3.200	4.037	2.64	0.014
4. Basic skills first	2.633	4.000	4.33	0.000
5. Alternative Assessment	3.767	4.296	1.84	0.078
6. Tell Objective	1.483	2.074	2.48	0.020
7. Calculators after Basics	2.667	4.000	4.24	0.000
8. Demonstration	3.069	4.148	2.87	0.008
9. Teach Procedures/Rules	3.367	4.272	3.15	0.004
10. Follow textbook	4.367	4.370	0.49	0.631
11. Correct all conjectures	2.633	4.154	4.94	0.000

The last set of keys assessed was the keys Unique to the Math Explorer. These were expected to be the keys most teachers were least familiar with. The range in knowledge of these keys on the pre-test was from zero to six, with the median equal to zero. Sizable change were noted on the post-test. The minimum score became four with a maximum number of keys known being all of them (10). The median went from zero to 9, and the mean went from 1.5926 to 8.4074. This difference was statistically significant (p=.000).

Coming into MSTEP, these teachers knew an average of 12 out of the 28 keys. Leaving the project, the teachers knew an average of 25 out of 28 keys. Thus, the teachers doubled their knowledge of keys. Additionally for each of the sets of keys, the lowest scoring person on the post-test was at least as high as the upper half of the third quartile for the pre-test. Substantial impact was made on the scientific keys, where not only the number of keys known increased, but the range in knowledge decreased.

A third analysis was performed on this calculator data. The percent of individuals knowing all the keys in each category at pre-test and at post-test is displayed on the stacked bar graph. The lightly shaded area refers to the percent of people knowing all the keys in each category on the pre-test. The darkly shaded area refers to the change from the pre-test to the post-test. Thus, the entire graph shows the percent of people knowing all the keys on the post-test. On the post-test, 93 percent of the participants knew all Basic keys, 63 percent knew all Scientific calculator keys, and 48 percent knew all Unique Math Explorer keys. A total of 45 percent (12 participants) knew all 28 function keys on the calculator on the post-test; this was as opposed to one person (3.7%) knowing all the keys on the pre-test.

These changes are not just statistically significant but educationally significant. Many of the same techniques that were employed for these students to learn the calculator keys can be used with middle school students. Part of MSTEP was to model many of the instructional techniques that are expected to be observed in a "reformed" math classroom. Using a calculator appropriately is one of these behaviors. But, in order to use a calculator in the class room for anything beyond simple addition, subtraction, multiplication, and division, knowledge of the calculator is essential. MSTEP seems to have provided their participants with a substantial foundation for using calculators in the classroom.

Classroom Practices Beliefs

Besides the knowledge of the calculator, the opinions of teaching practices need to change before impact will take place. The instrument What I Believe was administered at the same time as the calculator instrument was. This instrument focuses on several attitudes directly addressed in the NCTM Curriculum Standards. Two of the questions directly relate to the use of calculators in the classroom. This instrument attempts to identify the change in teaching practice attitudes as a result of MSTEP.

Paired t-tests were used to determine differences in the pre-test and post-test means. The What I Believe graph displays the results with statistically significant results noted by the probability (See table 2 for additional statistics). Seven of the 11 items showed statistically significant change in a positive direction. This means that the teachers moved from less than desirable reform positions to more desirable reform positions. Changes in attitudes were related to allowing students to struggle, introducing students to more advanced mathematics (i.e., probability, statistics, algebra) prior to being proficient in basic skills, using calculators in the classroom, and delaying the correction of false conjectures. In all cases where statistical significance was achieved there are visually large differences in the pre-test to post-test means.

There were areas where little impact occurred. The first is item 2. The participants already thought that whether a teacher did or did not use a calculator on tests should not influence whether a calculator was used in the classroom. The other item with very little change was 10. The teachers already thought that the sequence of the textbook did not have to be followed. In these cases, the opinions were not changes, but they were already had some "reform-minded" ideas. In all cases where the results were not statistically significant, the teachers already were leaning toward a reformed classroom (e.g. the means were greater than 3).

Conclusions

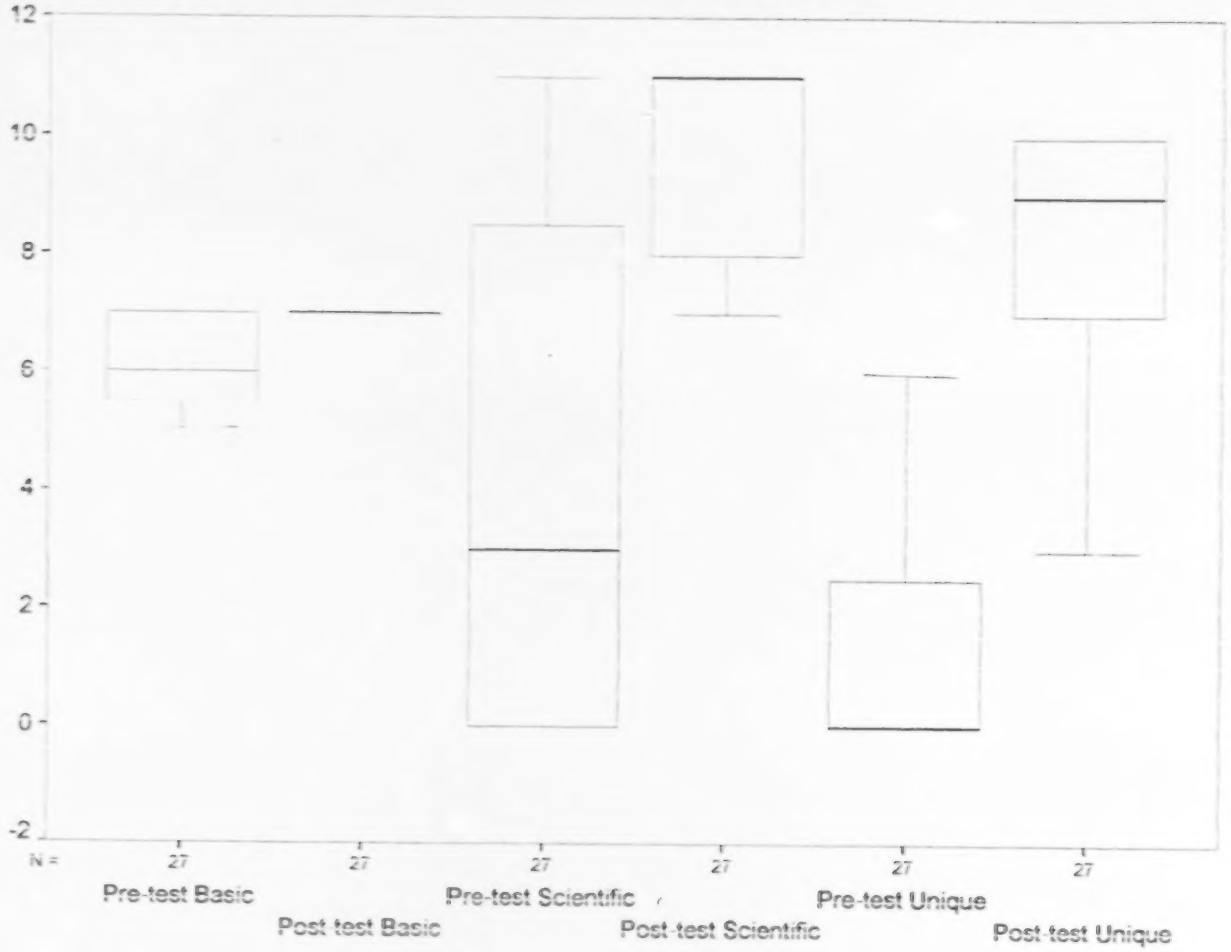
The six-week MSTEP program made some noteworthy changes in the skills and opinions of the 27 middle school teachers who participated. In just looking at two basic aspects of the project, these teachers have gained skills and changed opinions. This is not an easy task in a six-week project.

The teachers showed pivotal changes in their ability to employ calculators in the classroom. Without the knowledge of a calculator, a teacher can use if for little more than basic calculations. Once a teacher understands how the calculator works and learns how to use it as another teaching tool, it becomes more powerful. This is exactly what happened with the

MSTEP teachers. The change in the understanding of how a calculator could be used in the classroom is evidenced by the change in opinion on What I Believe item 7. The calculator is no longer thought of as a device to perform basic operations, but a more useful tool.

Besides the skills these teachers gained, they gained one project's idea of what "reformed" means. From those important reform ideas MSTEP wanted to reinforce, which are on What I Believe, most were presented in such a way that in six-week impacted these teachers. On seven of 11 items, the teachers moved significantly to a more reformed attitude. These are accomplishments that are a by-product of 29 days of modeling behaviors to show that it can work in a classroom.

Box and Whisker Plots of Calculator Keys



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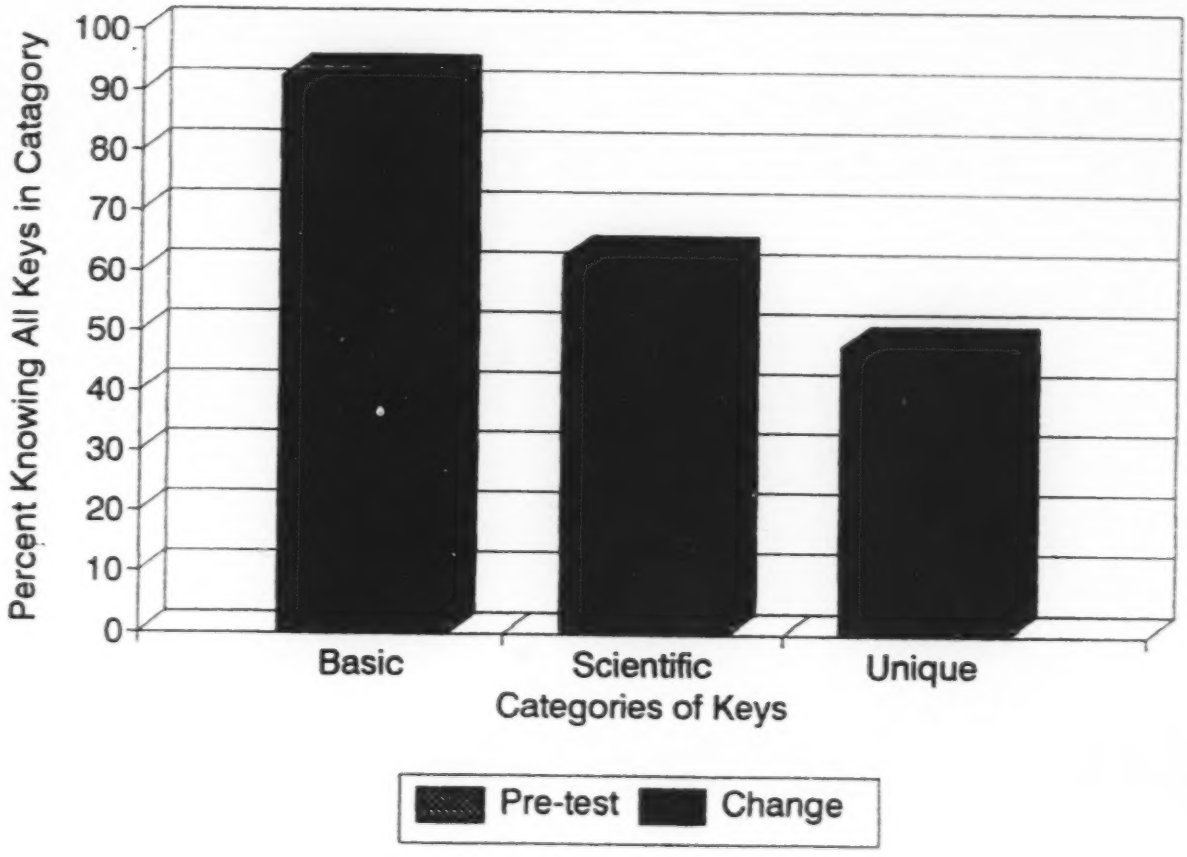
Percent of People Knowing All Keys



What I Believe

Circle the number that represents your attitude toward the statements.
1- Strongly Agree, 2 - Agree, 3 - No Opinion, 4 - Disagree, and 5 - Strongly Disagree.

1. It is easier for a student to learn mathematics when they are in a homogeneous class.
2. Calculators should not be used in the mathematics classroom if they are not used on tests.
3. Students should not be expected to struggle with problems they have not been taught how to solve.
4. Students should be proficient in basic skills before beign introduced to probability, statistics, and algebra.
5. Alternative assessment in the mathematics classroom is basically unfair to students because it is so subjective.
6. At the beginning of each lesson the students should be told the objective(s) of the lesson.
7. Calculators should be used in the mathematics classroom only after the basic facts are mastered.
8. The most efficient and effective solutions should be demonstrated in order for students to learn mathematics.
9. If procedures and rules are taught, then concepts will be understood when applications are taught.
10. It is best to follow the sequence of the textbook.
11. False conjectures should be corrected immediately.